THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

EVALUATION OF WAX-TREATED CORRUGATED BOARD BOXES FOR WET-PACK POULTRY

Project 1108-18

Progress Report Five

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

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EVALUATION OF WAX-TREATED CORRUGATED BOARD BOXES FOR WET-PACK POULTRY

SUMMARY

This report discusses the results obtained in a study to comparatively evaluate several combinations of wax-treated corrugated board for wet-pack poultry boxes. Six combinations of A-flute board were fabricated with water-resistant adhesive and impregnated with from 25 to 28% wax. The combinations were:

1. 69-33-42
2. 69-26-42
3. 47-33-47
4. 47-26-47
5. 42-33-42
6. 42-26-42

In addition, the Kieckhefer Container Corporation forwarded sixteen "Ice-o-box" containers to use as a control in the compression tests.

Two evaluation procedures were employed. In one, the boxes were filled with 10 lb. ice and four stacks of three boxes each were made from each sample. The bottom box in each stack was placed in a tray filled with about 1/2 water. After conditioning at 40°F. and 90% R.H. for 48 hours, the boxes were evaluated for compression strength. In the second evaluation

procedure, stacking tests were carried out on all samples (except the Ice-o-box) using the procedure described in Project 1108-18, Progress Report 2, Sept. 25, 1957, entitled "Comparative stacking evaluation of five wet-pack poultry-type boxes." For each combination, two stacks of 6 boxes each were assembled. Each box was packed with 24 dummy packages plus about 13 lb. ice.

The results may be summarized as follows:

PHASE I. COMPRESSION RESULTS

1. Top and center box position: All the wax-treated combinations exhibited higher compression strengths than the "Ice-o-box" except the 42-26-42 combination.

2. Bottom box position: For the boxes which stood in water for the 48-hour period, the wax-treated, 69-33-42 combination gave results approximately equal to the Ice-o-box. The other wax-treated combinations were from about 13 to 39% lower than the Ice-o-box.

PHASE II. STACK TESTS

1. In the stacking tests, the combinations ranked in about the order that would be expected from the weight of components used.

2. The 69-33-42 and 69-26-42 combinations approached the performance of the Ice-o-box (evaluated in a previous study) most closely.

Estimates of the cost of the various combinations including the cost of wax and the waxing operation indicated that all combinations were below the cost of either the Ice-o-box or the conventional wirebound crate.

INTRODUCTION

It has been found that when paraffin wax in the amount of 25 to 30% is applied to corrugated combined board either by roll coating or spraying and subsequently "cured" at 180 to 200°F., complete and uniform distribution of the wax among the fibrous components is obtained. Further, it has been found that boxes, made from corrugated board so treated, have remarkable strength when exposed to adverse moisture conditions. Preliminary results with wax impregnated board have indicated that it may have merit in the wet-packing of fresh eviscerated poultry. The purpose of this study was to comparatively evaluate several types of wax-treated corrugated board against a regular V_3c combination and the Ice-o-box (developed by the Kieckhefer Container Corporation). Two evaluation procedures were requested. In one, the boxes were to be filled with 10 pounds of ice and four stacks of three boxes each were to be made from each sample. The bottom box in each stack was to be placed in a tray filled with about 1/2 inch of water. The stacks were to be placed in an atmosphere of 40°F. and 90% relative humidity and the boxes were to be evaluated for compression strength after 48 hours. In the second evaluation procedure, stacking tests were to be carried out on all samples (except the Ice-o-box) using the procedure described in Progress Report Two, September 25, 1957, entitled, "Comparative stacking evaluation of five wet-pack poultry-type boxes."

As originally planned, the following combinations were to be evaluated:

1. 47-33-47--A-flute, waterproof adhesive, wax treated.
2. 47-26-47--A-flute, waterproof adhesive, wax treated.
3. 42-26-42--A-flute, waterproof adhesive, wax treated.
4. V_3c--B-flute
5. Ice-o-box--corrugated top and solid fiber bottom (in compression only.)

Because of delays in obtaining the V_3c board, the Institute was requested to proceed without the V_3c combination, and several additional combinations of wax-treated board were added to the program.

The two phases of the program could not be carried out concurrently because of cold room space limitations. For this reason, the results from each phase were collected together into preliminary reports to the subcommittee. These preliminary reports were dated February 26, 1958 and March 26, 1958. This present report summarizes the results from both phases of the program.

MATERIALS

The board combinations used in this study are tabulated in Table I.

TABLE I

NOMINAL WEIGHT, LB./1000 FT.^{2}

Run	Double-Face	Corrugating Medium	Single-Face
1	69	33	42
2	69	26	42
3	47	33	47
4	47	26	47
5	42	33	42
6	42	26	42

The above combinations were fabricated at the Menasha Wooden Ware Corporation on February 20 using a resorcinol adhesive on the single-facer and a Ketac adhesive on the double-facer. These adhesives, while usually considered to be "water-resistant" types rather than "waterproof" types were used for the following reasons.

1. Considerable savings in time and money could be and were effected in scheduling the fabrication of the required combinations. The Menasha Wooden Ware Corporation has had few--if any--orders calling for "waterproof" adhesives; consequently, scheduling the 6 combinations needed would have been difficult for them.

2. As a consequence of the fact that Menasha Wooden Ware Corporation has used "waterproof" adhesives on few occasions, it was felt that fabrication problems would be encountered. From this standpoint, it was felt that a well-applied "water-resistant" adhesive could give better performance than a poorly applied "waterproof" adhesive.

Samples of each combination were checked for compliance with the V_3c adhesion specifications. After 24 hours' immersion there was no evidence of delamination; however, it was found that delamination could be induced when the single-faced liner (bonded with resorcinol-starch) was repeatedly stressed with the thumb--the resulting delamination taking place because of the cohesive characteristics. In the case of the double-face adhesive (Ketac-starch), delamination was accompanied by a rupture or pulling of fibers. On the basis of the above, it appears that the adhesion, in general, was a borderline case with reference to the V_3c specification.

In consideration of the above, it was felt that the decision to use the resorcinal and Ketac adhesives was justified as it would allow the program to be expedited with little or no loss in box performance in either the compression or stacking tests.

In addition to the above board combinations, the Kieckhefer Container Corporation supplied sixteen "Ice-o-boxes" to be used as a reference in Phase I. These Ice-o-boxes were fabricated with corrugated board top and a solid fiber bottom and are believed to be identical in composition to the boxes evaluated as Set 1 in a previous study (see Project 1108-18, Progress Report Two, "Comparative stacking evaluation of five wet-pack poultry-type boxes," dated September 25, 1957.)

BOX CONSTRUCTION

The six combinations noted above were scored and slotted to give full telescope boxes with dimensions of 22 by 16 by 8 inches. The flutes in the body section were parallel to the 22-inch dimension and, in the cover, parallel to the 16-inch dimension. The laps were placed on the sides on the body and on the ends of the cover. The body sections were deep-slotted (3/8 inch below male) and rectangular drain holes were cut in both cover and body in the same locations as in the Ice-o-box. In the cover, the drain hole was centrally located and was 1-1/2 by 1/4-inch in size. In the body section the three drain holes were each 1-1/2 by 1/2 inch in size. A photograph of a typical box is shown in Figure 1.

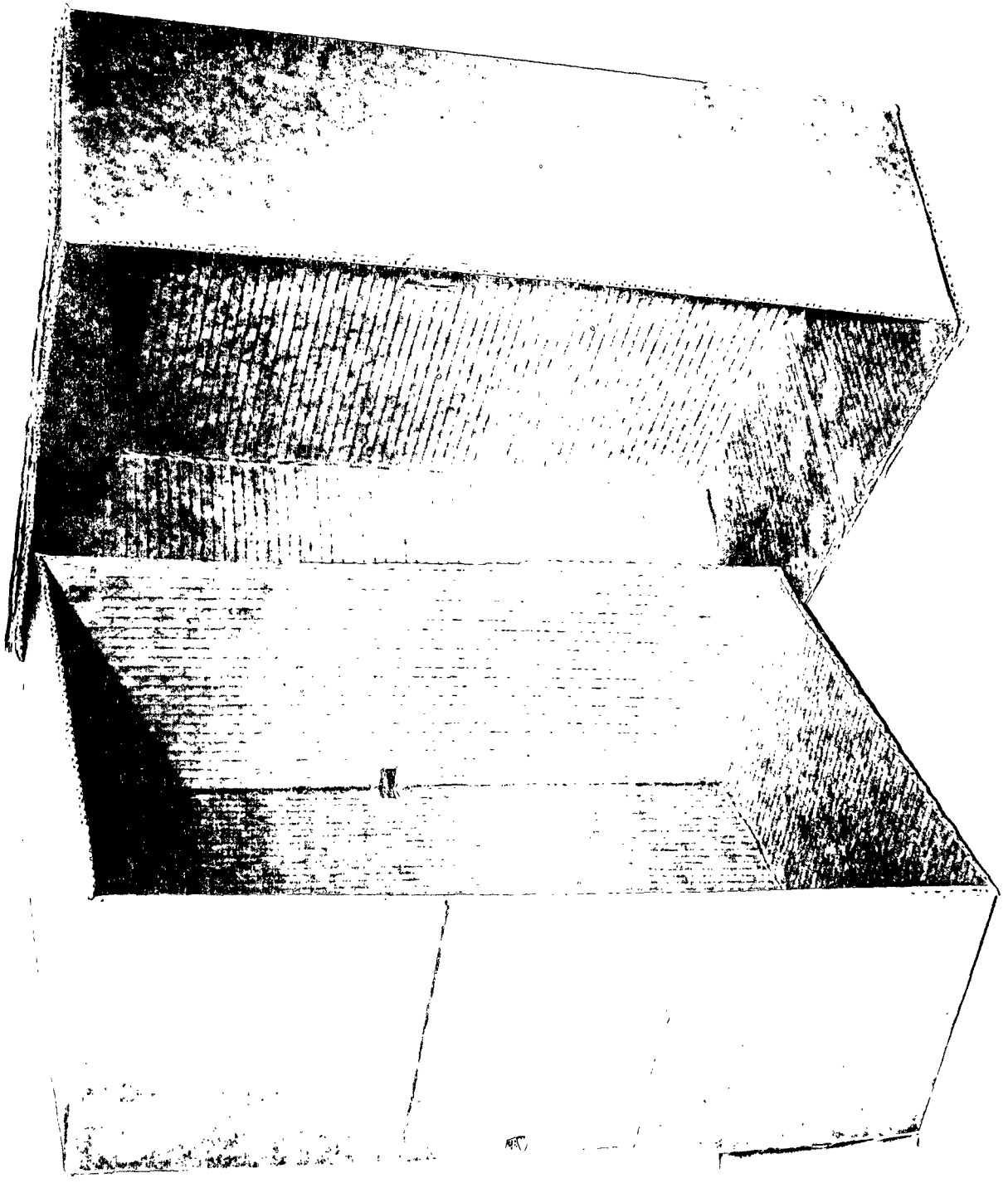


Figure 1
A Photograph of a Typical Box

WAX IMPREGNATION PROCEDURE

After scoring, each blank was waxed with paraffin (m.p. 127-129°) on a roll coater using a wax temperature of 140°F. The blanks were then cured in an oven at from 185 to 200°F. (See Project 1108-18, Progress Report 3, Study of Wax-impregnated Corrugated Board, March 3, 1958, for details of impregnation processes.) At the end of the curing period, the blanks were allowed to cool in an atmosphere of high humidity and then slotted and stitched. Analysis of the impregnated board for wax pick-up (carbon tetrachloride extraction method) gave the results shown in Table II. As may be noted in the table, wax contents ranged from 24.7 to 30.0% for the individual components--liners and corrugating medium--and from 25.0 to 28.3% on the averages for each combination.

TABLE II

WAX CONTENT

Combination	Wax Content, %* Single-Face Liner	Double-Face Liner	Corrugating Medium	Average
69-33-42	28.0	28.9	26.0	27.6
69-26-42	27.6	26.6	28.5	27.6
47-33-47	27.4	27.4	27.8	27.5
47-26-47	25.2	25.6	27.4	26.1
42-33-42	27.9	30.0	26.9	28.3
42-26-42	25.2	25.2	24.7	25.0

* On ovendry basis.

PRECOMPRESSION TEST STACKING PROCEDURE

Twelve boxes from each sample were subjected to the following conditions prior to their compression evaluation. Each box was filled with 10 lb. of crushed ice and the boxes were then placed in four stacks of three boxes each. The bottom box in each stack was placed in a tray filled to about 1/2 inch in depth with water. The stacks were held for 48 hours at 40°F. and 90% relative humidity prior to test. At the end of the 48 hours the boxes were removed one by one from the cold room and tested immediately at 50% relative humidity and 73°F.

STACK TEST PROCEDURES

Procedures employed in this study for the stack tests were essentially the same as those used in a previous study--(see "Comparative stacking evaluation of five wet-pack poultry-type boxes," Project 1108-18, Progress Report 2, Sept. 25, 1957). A brief resumé of the procedures is given below.

1. Two stacks of 6 boxes each were wet up for each combination. The two stacks for each combination were arbitrarily identified by the letters "A" and "B."

2. Each box was filled with 24 dummy packages (containing 0.75 lb. wet wood shavings and 1.45 lb. sand) and about 13 lb. ice. The appearance of a typical box after packing is shown in Figure 2.

3. After the boxes were packed, the boxes were stacked in proper order in an insulated truck. Figure 3 illustrates the appearance of the boxes in the truck. The floor of the truck was wet down thoroughly before placing the box in the truck. The journey in the truck covered

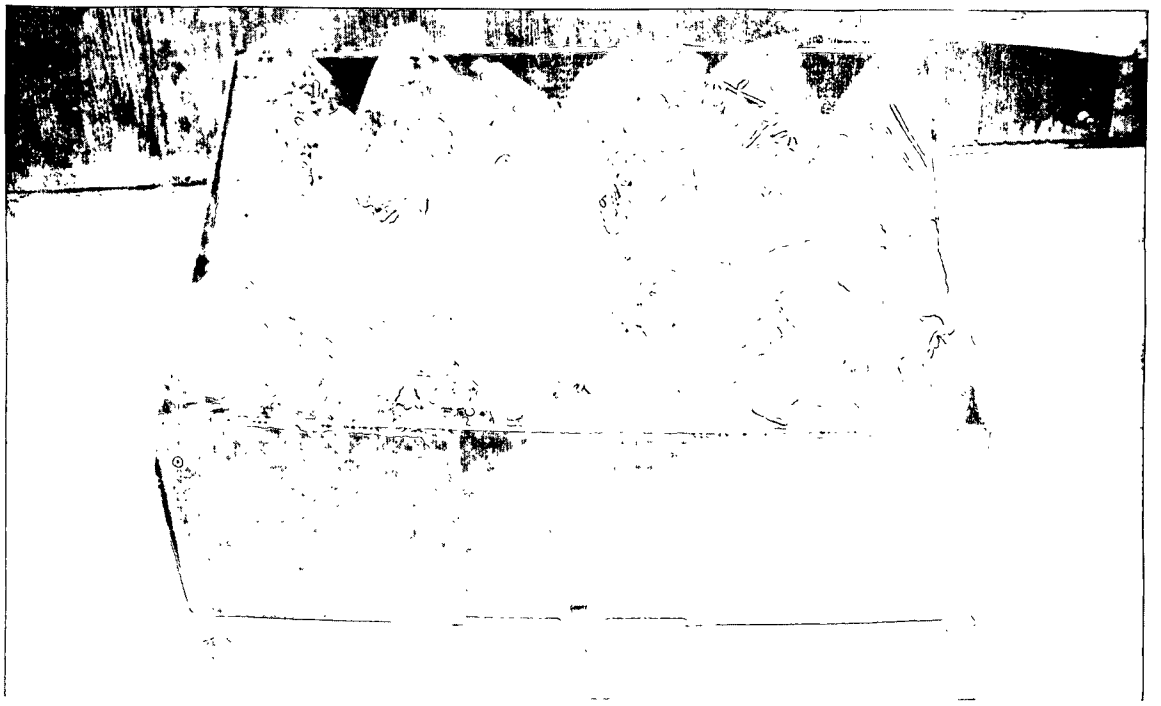


Figure 2
Typical Packed Box

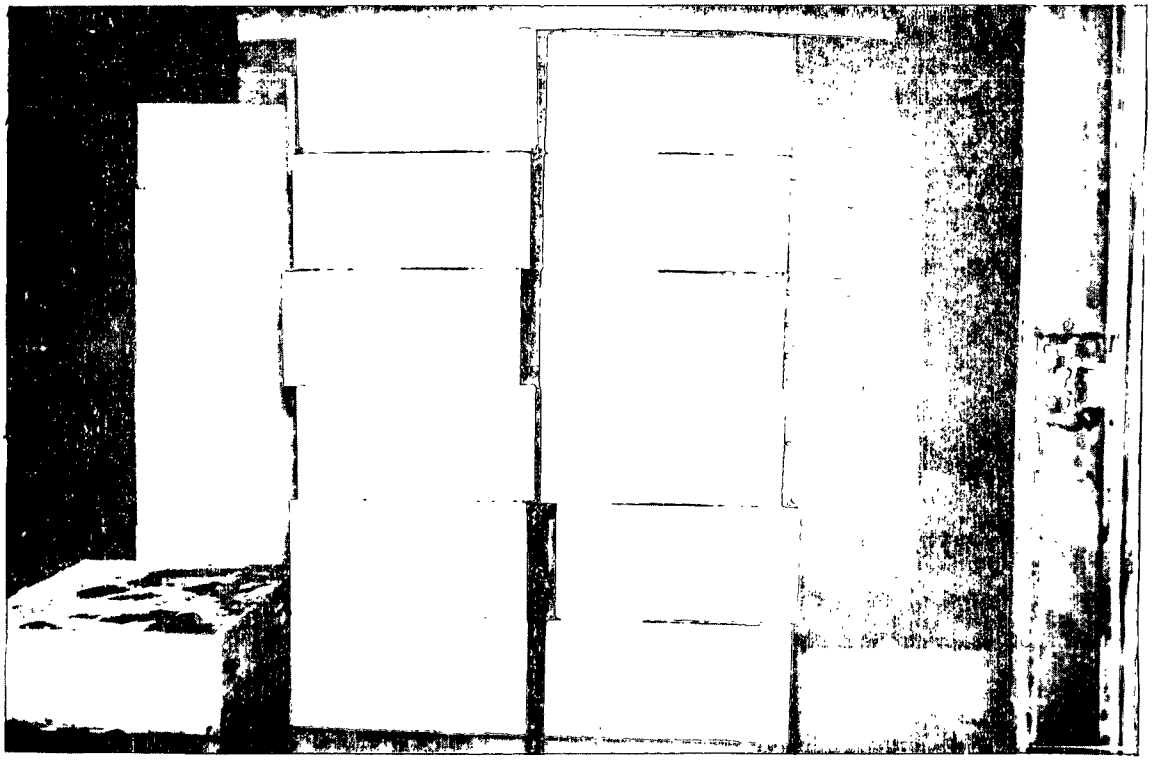


Figure 3
Appearance of Boxes in Truck

about 100 miles on U. S. Highway 10 from Appleton to Two Rivers, Wisconsin, and back. When the truck was opened on its return, it was found that two stacks had toppled over--apparently, as the truck entered The Institute of Paper Chemistry grounds. The two stacks concerned were the A and B stacks of the 42-33-42 combination. It was also noted as the stacks were unloaded that two of the stacks in the right front corner of the truck stood in from 1/2 to 1 inch of water--the pool of water was caused by a forward tilt of the truck body--perhaps caused by uneven ground at the loading dock. The two stacks concerned were the A stack of the 42-26-42 combination and the B stack of the 47-33-47 combination.

4. When the truck returned, the stacks were set up in the cold room at 40°F. and 90% R.H. in the same vertical arrangement as on the truck. These particular conditions were selected to correspond to the conditions used in the compression tests. Daily measurements of stack inclination and change in stack height were then taken for 11 days at which time the boxes were unpacked.

5. The following weights were obtained during the packing and unpacking operation.

a. Empty box weight

b. Weight of dummy packages

c. Total box weight

d. Ice weight (by difference)

DISCUSSION OF RESULTS

PHASE I. COMPRESSION RESULTS

The compression results on the individual boxes are tabulated in Table III and summarized in Table IV. As would be expected, the top and center boxes in each stack yielded approximately equal compression results. The bottom boxes, on the other hand, which were in contact with the tray water during the pretest exposure period exhibited much lower compression strengths--from about 1/3 to 1/2 of the strength exhibited by the upper boxes. Those areas of the lower boxes in direct contact with the water were quite "soft" to the touch for all samples, although the solid fiber bottom of the Ice-o-box appeared to be affected to a somewhat lesser extent.

In Table III, where the results are compared to the Ice-o-box, it may be noted that, for the top and center box positions, all the wax-treated combinations except the 42-26-42 give higher results than the Ice-o-box. For the more stringent and, perhaps, more realistic conditions associated with the bottom box position, only the 69-33-42 combination gave somewhat higher results than the Ice-o-box and that difference was of doubtful significance. The 69-26-42 combination was 12.8% lower than the Ice-o-box while the remaining combinations exhibited decreases from about 23 to 39%.

PHASE II. STACK TEST RESULTS

As discussed previously, two stacks (6 boxes high) were set up for each combination. The boxes were filled with 24 dummy packages

TABLE III

INDIVIDUAL BOX COMPRESSION RESULTS

Combination	Stack	Box Compression Maximum Load (0 to 1.00 in.), lb.			Deflection, in.		
		Top Box	Center Box	Bottom Box	Top Box	Center Box	Bottom Box
69-33-42	A	4420	3730	1325	0.88	0.66	1.00
	B	3605	3895	1200	0.62	0.70	0.64
	C	4335	4380	1850	0.71	0.58	1.00
	D	4200	4070	2275	0.81	0.80	1.00
	Average	4140	4020	1660	0.76	0.68	0.91
69-26-42	A	3600	3625	1300	0.64	0.69	1.00
	B	3750	3595	1125	0.88	0.68	0.42
	C	3870	3785	1300	0.78	0.92	1.00
	D	4255	4315	1875	0.58	0.65	1.00
	Average	3870	3830	1400	0.72	0.74	0.86
47-33-47	A	4310	4720	1250	0.73	0.76	0.75
	B	3955	4075	1075	0.67	0.70	0.69
	C	4190	3840	1125	0.69	0.80	0.78
	D	3920	3860	1500	0.86	0.70	1.00
	Average	4095	4125	1240	0.74	0.74	0.80
47-26-47	A	3380	3470	1050	0.70	0.72	0.31
	B	3375	3310	1000	0.92	0.64	1.00
	C	3145	3005	1050	0.65	0.89	1.00
	D	3355	3390	900	0.72	0.68	0.88
	Average	3315	3295	1000	0.75	0.73	0.80
42-33-42	A	3500	3620	1075	0.87	0.78	0.66
	B	3605	3635	1050	0.75	0.62	0.66
	C	3485	3550	1050	0.90	0.79	0.52
	D	4160	3145	1050	0.74	0.72	0.69
	Average	3690	3490	1055	0.82	0.73	0.63
42-26-42	A	2760	3080	1000	0.58	0.78	0.75
	B	3220	2780	1000	0.74	0.86	0.84
	C	3060	3025	1000	0.90	0.90	0.68
	D	2850	2575	925	0.69	0.72	0.71
	Average	2970	2865	980	0.73	0.82	0.74
Ice-o-box	A	3110	2790	1725	0.48	0.42	0.36
	B	3170	2840	1925	0.43	0.46	1.00
	C	3020	3265	1500	0.44	0.38	0.42
	D	3090	3070	1275	0.47	0.36	0.37
	Average	3100	2990	1605	0.46	0.40	0.54

TABLE IV

SUMMARY OF COMPRESSION RESULTS

Combination	Box Compression (0 to 1.0 in.), lb. Top Box	Difference, %[a]	Center Box	Difference, %[a]	Bottom Box	Difference, %[a]
Ice-o-box	3100	--	2990	--	1605	--
69-33-42	4140	+33.5	4020	+34.4	1660	+3.4
69-26-42	3870	+24.8	3830	+28.1	1400	-12.8
47-33-47	4095	+32.1	4125	+38.0	1240	-22.7
47-26-47	3315	+6.9	3295	+10.2	1000	-37.7
42-33-42	3690	+19.0	3490	+16.7	1055	-34.3
42-26-42	2970	-4.2	2865	-4.2	980	-38.9

[a] Based on Ice-o-box results as reference.

and about 13 lb. of ice. Measurements of stack inclinations and change in height at the top box and bottom box were then made over 11 days. It should be mentioned that the 11-day storage period is considerably longer than would normally be encountered with wet-pack poultry. From this standpoint comparisons of stack behavior at the shorter time intervals, such as 4 to 7 days, may be more realistic in terms of "normal" use requirements. With the above in mind, a summary of the inclination measurements may be found in Table V. Referring to the table, it may be noted that the combinations fabricated with two 42-lb. kraft liners gave the greatest inclinations in general. Thus, extremely high inclinations were recorded for both stacks of 42-26-42 combination and one of the 42-33-42 stacks. It may be remarked that the extremely high inclination recorded for the B-stack of the 42-33-42 combination probably resulted from damage incurred when this stack toppled over in the truck. As might be expected, the combinations fabricated with 69-42 lb. liners tended to give the smallest stack inclinations with the 47-lb. liner combinations, ranking between the 69-42 and 42-42 combinations. It may be remarked that the combinations fabricated with the heavier weight (33 lb.) mediums tended to exhibit less inclination than did the 26-lb. medium combinations. When the results for the wax-treated boxes are compared to the results obtained for the "Ice-o-box" evaluated in a previous study (see Comparative Stacking Evaluation of Five Wet-Pack Poultry Type Boxes, Progress Report Two, Project 1108-18, Sept. 25, 1957), it appears that the 69-33-42 and 69-26-42 combinations approached the Ice-o-box performance most closely.

TABLE V

INCLINATION OF STACKS

Exposure, days	Ice-o-box[a]	Stack Inclination, inches 69-33-42	69-26-42	47-33-47	47-26-47	42-33-42	42-26-42
			Stack A				
1	0.15	0.25	0.95	0.75	0.30	0.25	0.75
2	0.20	0.35	1.10	0.75	0.40	0.45	1.10
3	0.20	0.40	1.10	0.75	0.50	0.65	1.65
4	0.20	0.60	1.15	0.75	0.80	0.80	2.20
5	0.35	0.65	1.30	0.75	1.00	0.90	3.20
6	0.35	0.70	1.35	0.80	1.30	1.00	3.75
7	0.35	0.75	1.45	0.80	1.50	1.15	4.00
8	--	0.75	1.55	0.80	1.75	1.25	4.25
9	--	0.85	1.60	0.80	1.85	1.35	4.50
11	--	0.90	1.70	0.85	2.00	1.50	5.00
			Stack B				
1	0	0.20	0.50	0.25	0.95	1.10	0.55
2	0	0.25	0.60	0.55	1.00	1.90	1.40
3	0.05	0.25	0.75	0.95	1.00	2.55	2.15
4	0.05	0.35	0.80	1.20	1.10	3.45	2.75
5	0.10	0.35	0.80	1.45	1.30	4.50	3.30
6	0.10	0.40	0.80	1.65	1.40	5.30	3.60
7	0.15	0.40	0.80	1.85	1.60	6.00	3.90
8	--	0.40	0.80	2.00	1.80	6.50	3.95
9	--	0.40	0.80	2.20	2.00	7.00	4.20
11	0.20	0.40	0.90	2.50	2.35	8.05	4.40
			Average of Both Stacks				
4	0.12	0.48	0.98	0.98	0.95	2.12	2.48
7	0.20	0.58	1.12	1.32	1.55	3.58	3.95
11	--	0.65	1.30	1.68	2.18	4.78	4.70

[a] Results taken from Project 1108-18, Progress Report 2, to the Fourdrinier Kraft Board Institute, Inc., Sept. 25, 1957--Set 1, corrugated top and solid fiber bottom.

Photographs were taken of the stacks after various storage periods. Figures 4a and 4b show the appearance of the stack after 1 day and Figure 5 illustrates the appearance of two of the bottom boxes after 1 day. Figures 6a through 10 show stack appearance after 5, 7 and 11 days, respectively. Figure 11 illustrates the appearance of the covers on the bottom boxes after unpacking.

The changes in height of the stacks at the top and bottom boxes are summarized in Tables VIA and VIB, respectively. Referring to the table, it may be noted that the results tend to rank the combinations in much the same order as the inclination measurements discussed above.

As was done in the original study, measurements of the change in box and ice weights were made in this study. The results obtained are summarized in Tables VII and VIII. As may be noted in Table VII, the ice was almost completely melted at the end of the test period. This was in contrast to the results obtained in the previous study where from 2 to 3 lb. of ice remained after 11 days. It is believed that the greater rate of melting encountered in this study was caused by three factors:

1. The boxes in this study were filled with slightly less ice than was used in the previous study.

2. The dummy packages in the previous study were stored in the cold room for at least 10 days prior to packing. This allowed more time for the package to come to temperature equilibrium in the cold room. In this study the dummy packages were prepared during the five or six days

TABLE VIA

CHANGE IN HEIGHT OF STACKS

Exposure, days	Ice-o-box [a]	Change in Height at Top Box, inches					
		69-33-42	69-26-42	47-33-47	47-26-47	42-33-42	42-26-42
				Stack A			
1	0	0.20	0.10	0.05	0.15	0.20	0.20
2	0.05	0.20	0.10	0.10	0.25	0.35	0.45
3	0.05	0.20	0.10	0.10	0.35	0.40	0.65
4	0.05	0.20	0.10	0.10	0.40	0.45	0.80
5	0.10	0.25	0.20	0.10	0.50	0.50	1.15
6	0.10	0.25	0.20	0.15	0.55	0.50	1.30
7	0.10	0.25	0.25	0.15	0.75	0.70	1.50
8	--	0.30	0.25	0.15	0.80	0.75	1.60
9	--	0.35	0.30	0.20	0.85	0.80	1.75
11	--	0.35	0.35	0.20	0.95	0.85	1.90
				Stack B			
1	0.05	0.10	0.05	0.10	0.20	0.25	0.25
2	0.05	0.15	0.10	0.15	0.30	0.45	0.50
3	0.05	0.15	0.10	0.25	0.35	0.65	0.75
4	0.05	0.20	0.20	0.25	0.35	0.75	0.85
5	0.10	0.20	0.20	0.25	0.45	1.00	0.95
6	0.10	0.25	0.20	0.35	0.45	1.15	1.15
7	0.10	0.30	0.25	0.45	0.55	1.40	1.25
8	--	0.30	0.30	0.45	0.55	1.55	1.35
9	--	0.35	0.30	0.55	0.65	1.60	1.45
11	0.10	0.35	0.30	0.60	0.75	1.80	1.55
				Average of Both Stacks			
4	0.05	0.20	0.15	0.18	0.38	0.60	0.82
7	0.10	0.28	0.25	0.30	0.65	1.05	1.38
11	--	0.35	0.32	0.40	0.85	1.32	1.72

[a] Results taken from Project 1108-18, Progress Report 2, to the Fourdrinier Kraft Board Institute, Inc., Sept. 25, 1957--Set 1, corrugated top and solid fiber bottom.

TABLE VIB

CHANGE IN HEIGHT OF STACKS

Exposure, days	Ice-o-box [a]	Change in Height at Top of Bottom Box, inches 69-33-42	69-26-42	47-33-47	47-26-47	42-33-42	42-26-42
			Stack A				
1	0.05	0.05	0	0.10	0.15	0.05	0.20
2	0.05	0.10	0.05	0.10	0.25	0.10	0.30
3	0.05	0.10	0.05	0.15	0.30	0.15	0.50
4	0.05	0.10	0.10	0.15	0.35	0.20	0.70
5	0.05	0.10	0.10	0.15	0.35	0.20	0.90
6	0.10	0.10	0.15	0.15	0.40	0.20	1.00
7	0.10	0.10	0.15	0.15	0.50	0.25	1.10
8	--	0.10	0.15	0.15	0.55	0.25	1.10
9	--	0.10	0.15	0.20	0.55	0.30	1.15
11	--	0.10	0.15	0.25	0.60	0.30	1.20
			Stack B				
1	0.05	0.05	0	0.05	0.10	0.20	0.10
2	0.05	0.10	0.05	0.15	0.15	0.35	0.25
3	0.05	0.10	0.10	0.20	0.20	0.50	0.40
4	0.05	0.10	0.15	0.25	0.30	0.50	0.50
5	0.05	0.15	0.15	0.30	0.30	0.60	0.55
6	0.05	0.15	0.20	0.35	0.35	0.65	0.65
7	0.05	0.15	0.20	0.40	0.35	0.70	0.65
8	--	0.20	0.20	0.45	0.35	0.85	0.65
9	--	0.20	0.25	0.45	0.40	0.90	0.70
11	0.05	0.20	0.25	0.50	0.45	1.00	0.75
			Average of Both Stacks				
4	0.05	0.10	0.12	0.20	0.32	0.35	0.60
7	0.08	0.12	0.18	0.28	0.42	0.48	0.88
11	--	0.15	0.20	0.38	0.52	0.65	0.98

[a] Results taken from Project 1108-18, Progress Report 2, to the Fourdrinier Kraft Board Institute, Inc., Sept. 25, 1957--Set 1, corrugated top and solid fiber bottom.

TABLE VII

LOSS OF ICE DURING STORAGE PERIOD OF 11 DAYS

Box No.	Weight of Ice, lb. 69-33-42 Start	69-33-42 End	69-26-42 Start	69-26-42 End	47-33-47 Start	47-33-47 End	47-26-47 Start	47-26-47 End	42-33-42 Start	42-33-42 End	42-26-42 Start	42-26-42 End
					Stack A							
1	13.1	0.02	13.2	0.05	13.4	0.21	12.7	0.14	13.6	0.02	13.8	0.01
2	13.1	0.02	13.3	0.03	13.4	0.09	12.7	0.02	13.6	0.01	13.8	0.02
3	13.1	0.02	13.3	0.02	13.4	0.02	12.7	0.02	13.6	0.02	13.8	0.21
4	13.1	0.02	13.2	0.02	13.4	0.02	12.7	0.01	13.6	0.01	13.8	0.06
5	13.0	0.01	13.2	0.02	13.4	0.03	12.7	0.03	13.6	0.01	13.8	0.07
6	13.1	0.03	13.2	0.02	13.4	0.01	12.7	0.02	13.6	0.02	13.8	0.10
Av.	13.1	0.02	13.2	0.03	13.4	0.06	12.7	0.04	13.6	0.02	13.8	0.08
					Stack B							
1	14.1	0.08	14.2	0.08	13.5	0.46	13.7	0.02	13.6	0.02	13.8	0.04
2	14.0	0.02	14.2	0.02	13.4	0.02	13.7	0.02	13.6	0.01	13.8	0.01
3	14.1	0.04	14.2	0.09	13.4	0.00	13.7	0.02	13.7	0.01	13.8	0.01
4	14.5	0.01	14.2	0.04	13.4	0.22	13.7	0.02	13.6	0.01	13.8	0.02
5	14.1	0.02	14.2	0.03	13.4	0.00	14.7	0.01	13.6	0.01	13.8	0.05
6	14.1	0.01	14.2	0.01	13.4	0.04	14.7	0.02	13.6	0.03	13.8	0.01
Av.	14.2	0.03	14.2	0.04	13.4	0.12	14.0	0.02	13.6	0.02	13.8	0.02

TABLE VIII

CHANGE IN BOX WEIGHT AFTER 11 DAYS' STORAGE

Box No.	Empty Box Weight, lb. 69-33-42 Start	69-33-42 End	69-26-42 Start	69-26-42 End	47-33-47 Start	47-33-47 End	47-26-47 Start	47-26-47 End	42-33-42 Start	42-33-42 End	42-26-42 Start	42-26-42 End
					Stack A							
1	4.10	5.11	3.98	5.00	3.79	5.13	3.54	4.78	3.56	4.58	3.39	4.64
2	4.13	4.94	3.94	4.61	3.80	4.57	3.50	4.23	3.56	4.35	3.38	3.98
3	4.10	4.90	3.94	4.57	3.80	4.57	3.52	4.25	3.57	4.30	3.37	4.04
4	4.13	4.90	3.99	4.61	3.78	4.45	3.54	4.20	3.60	4.28	3.38	3.94
5	4.15	4.93	3.95	4.56	3.75	4.49	3.53	4.22	3.58	4.29	3.35	3.93
6	4.14	4.87	4.00	4.50	3.77	4.36	3.51	4.10	3.56	4.19	3.37	3.90
Av.	4.12	4.94	3.97	4.64	3.78	4.60	3.52	4.30	3.57	4.33	3.37	4.07
Change, %[a]	--	+20	--	+17	--	+22	--	+22	--	+21	--	+21
					Stack B							
1	4.11	5.37	3.95	5.19	3.74	5.19	3.52	4.81	3.56	4.49	3.38	4.38
2	4.15	4.94	3.97	4.84	3.77	4.51	3.49	4.33	3.58	4.29	3.36	4.08
3	4.13	4.98	3.96	4.80	3.76	4.50	3.53	4.29	3.54	4.29	3.36	4.07
4	4.18	4.92	3.98	4.79	3.79	4.53	3.51	4.18	3.56	4.27	3.36	4.00
5	4.14	4.84	3.98	4.80	3.78	4.50	3.51	4.20	3.57	4.28	3.37	3.99
6	4.11	4.78	3.97	4.66	3.79	4.46	3.52	4.11	3.57	4.11	3.36	3.83
Av.	4.14	4.97	3.97	4.85	3.77	4.62	3.51	4.32	3.56	4.29	3.36	4.06
Change, %[a]	--	+20	--	+22	--	+23	--	+23	--	+21	--	+21

[a]Based on "start" results as reference.

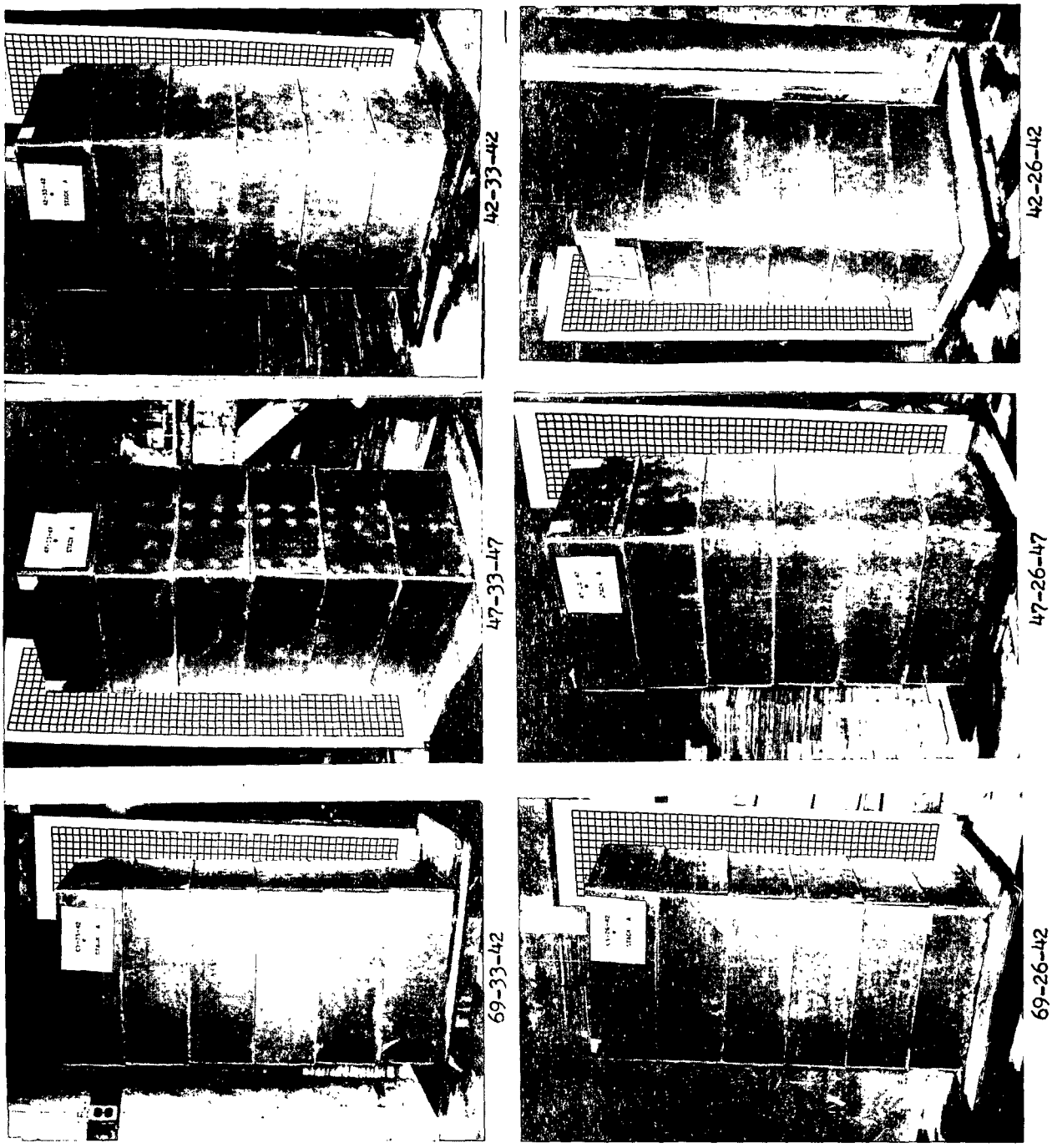


Figure 4a
Appearance of Stacks after One Day (A Stacks)

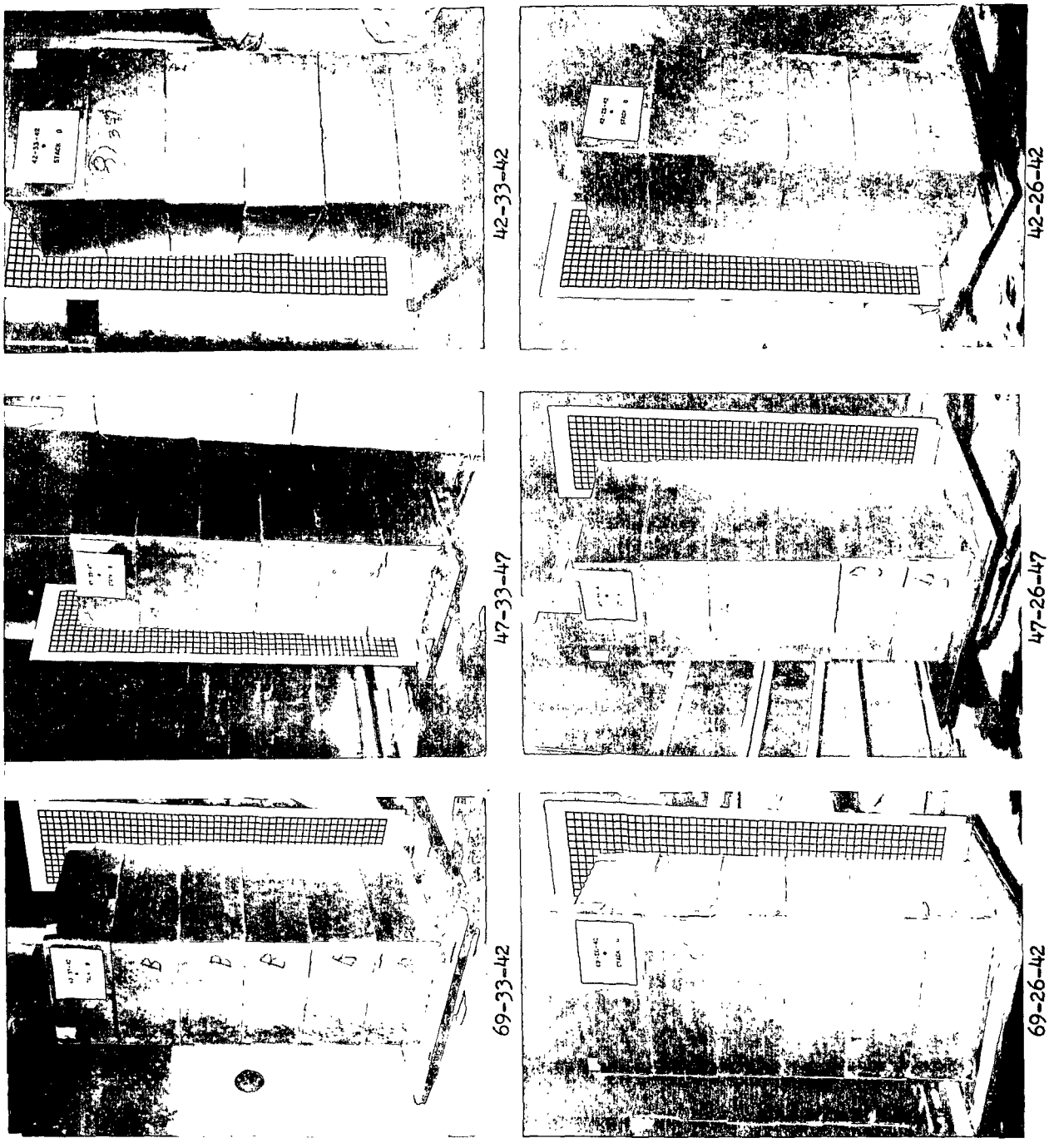


Figure 4b
Appearance of Stacks after One Day (B Stacks)

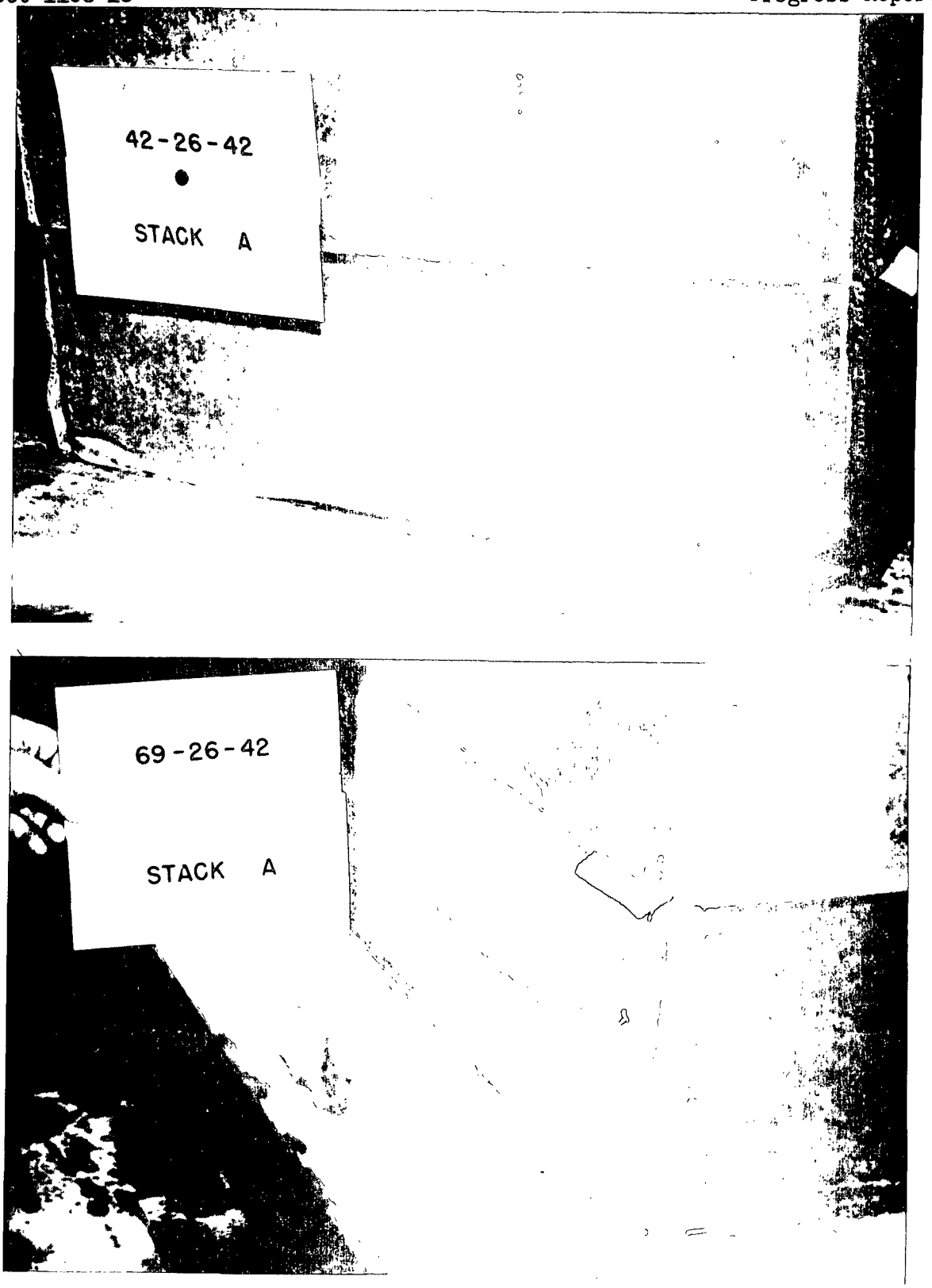


Figure 5

Appearance of Lower Boxes in Two Stacks after One Day

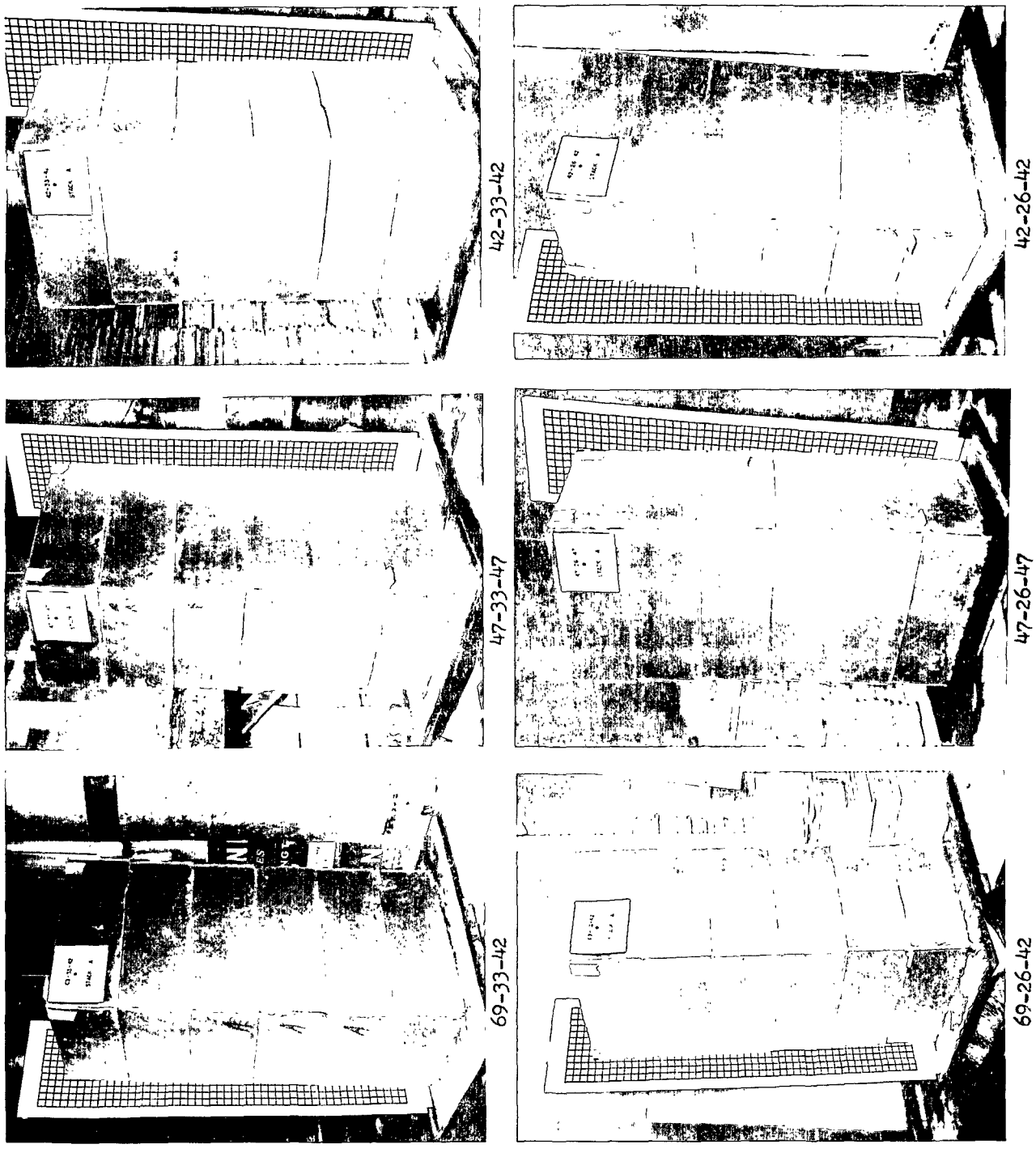


Figure 6a
Appearance of Stacks after Five Days (A Stacks)

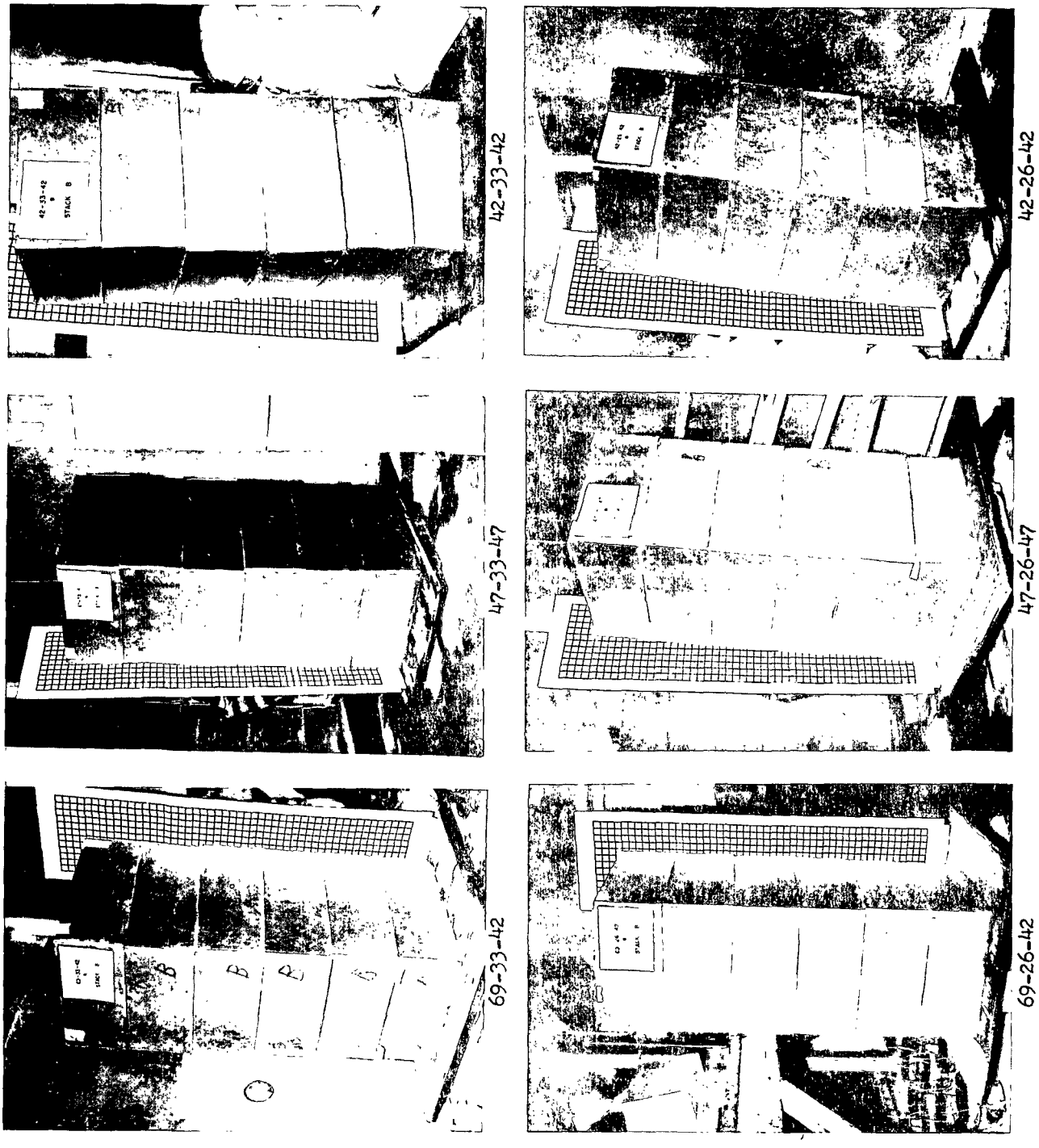
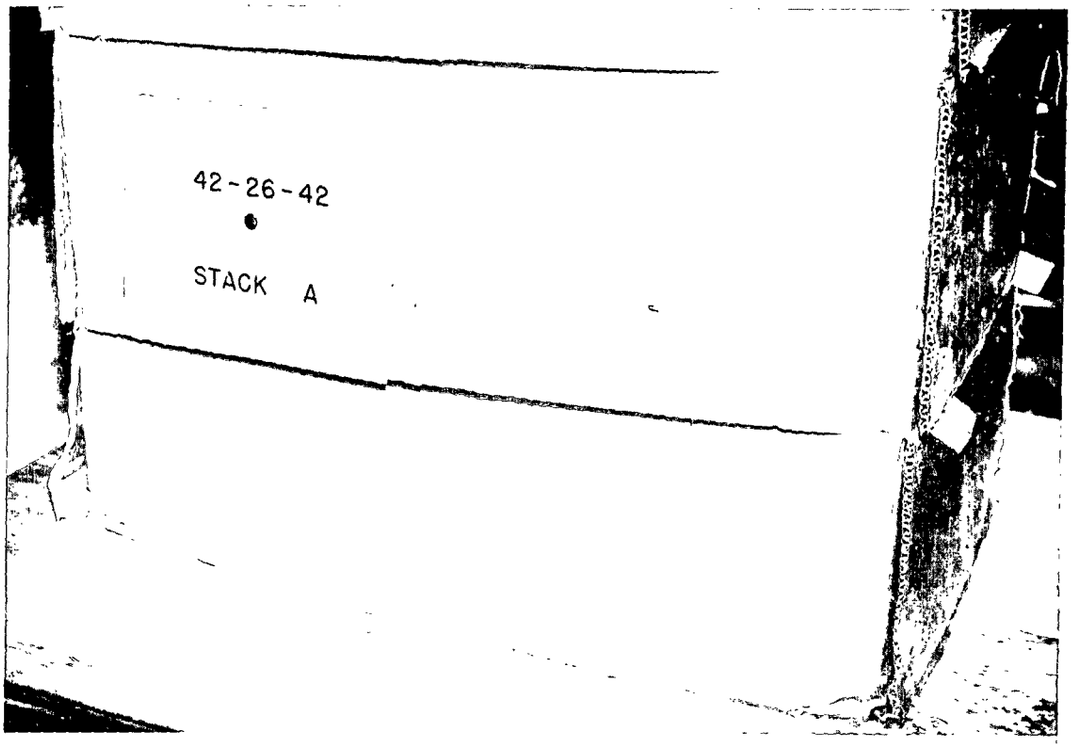


Figure 6b
Appearance of Stacks after Five Days (B Stacks)



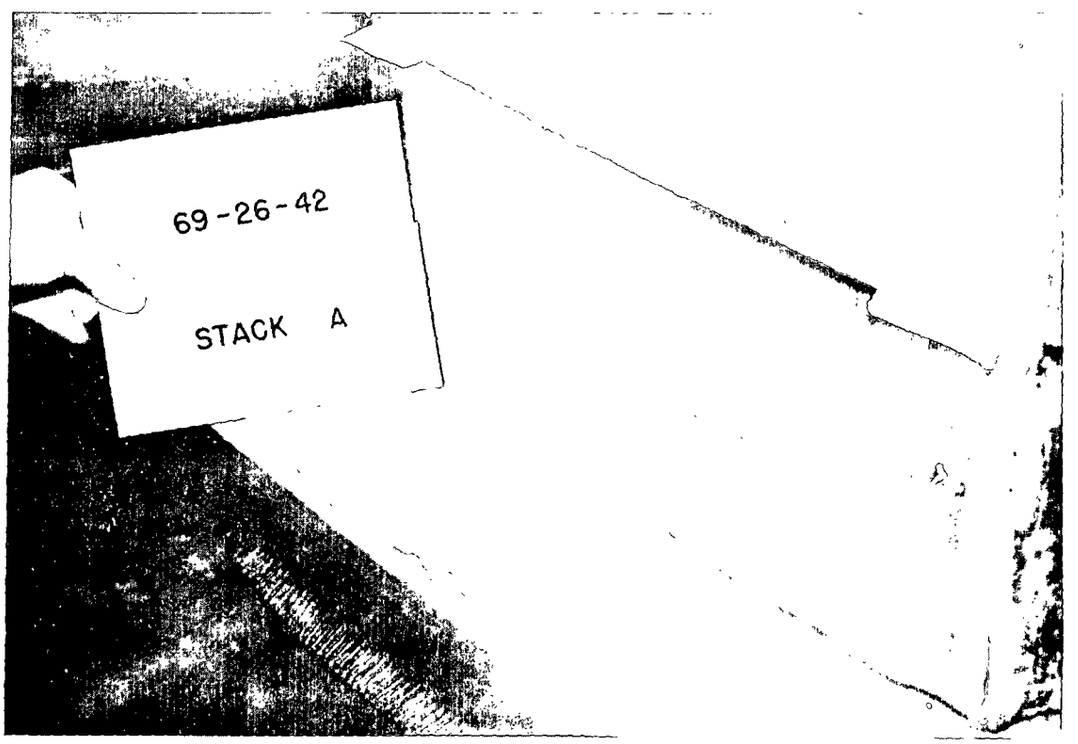


Figure 7

Appearance of Lower Boxes in Two Stacks after Five Days

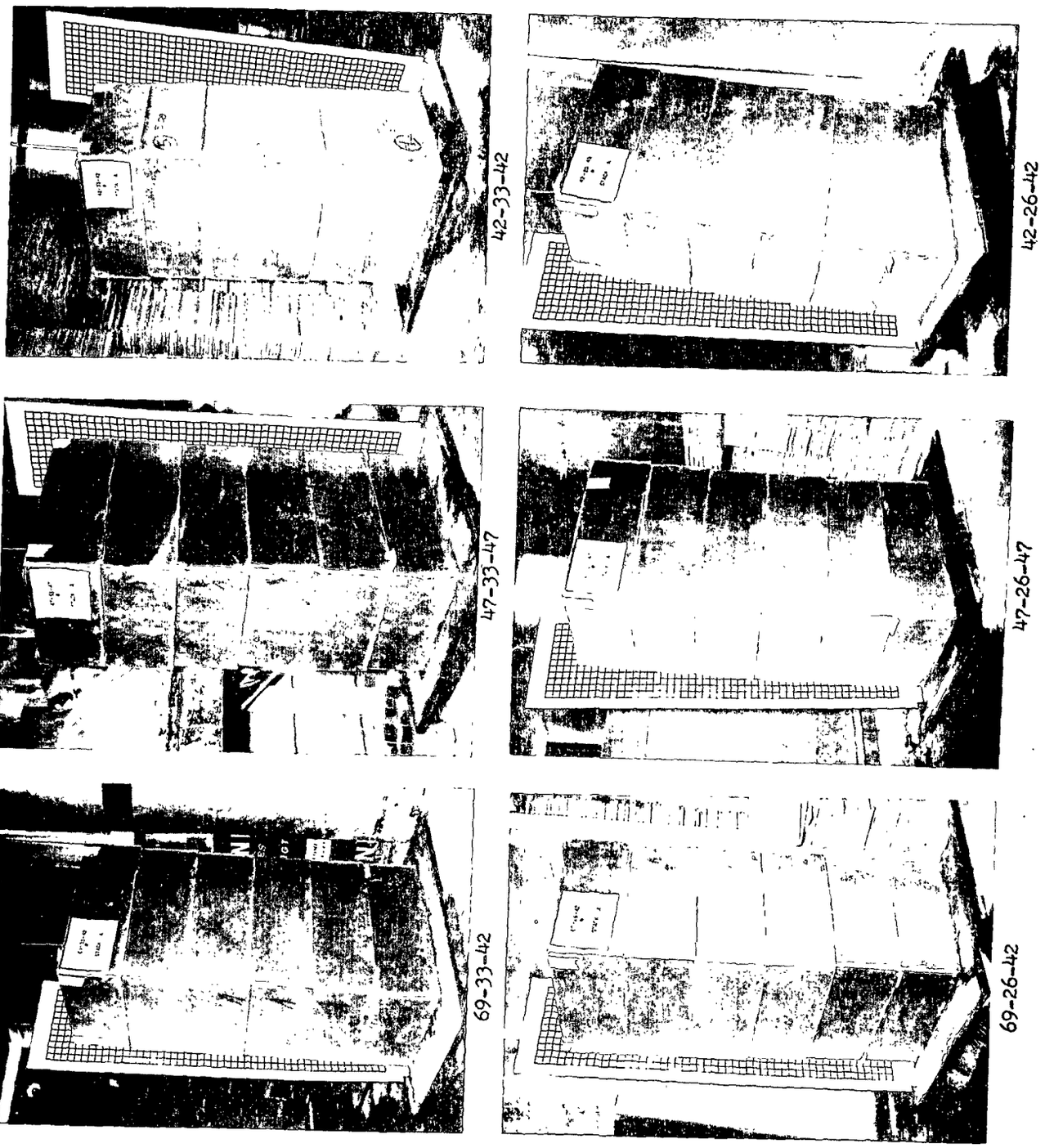


Figure 8a
Appearance of Stacks after Seven Days (A Stacks)

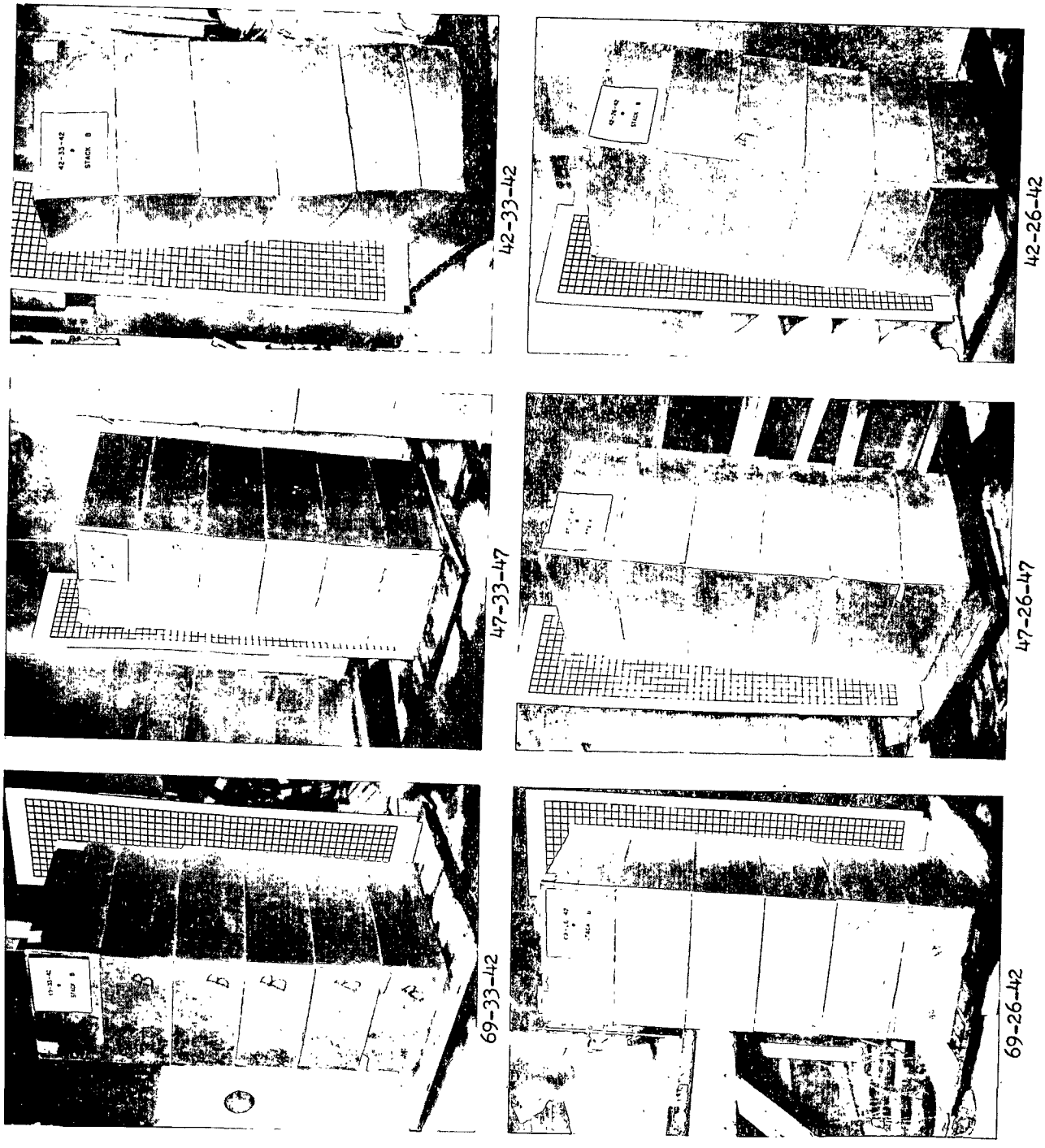


Figure 8b
Appearance of Stacks after Seven Days (B Stacks)

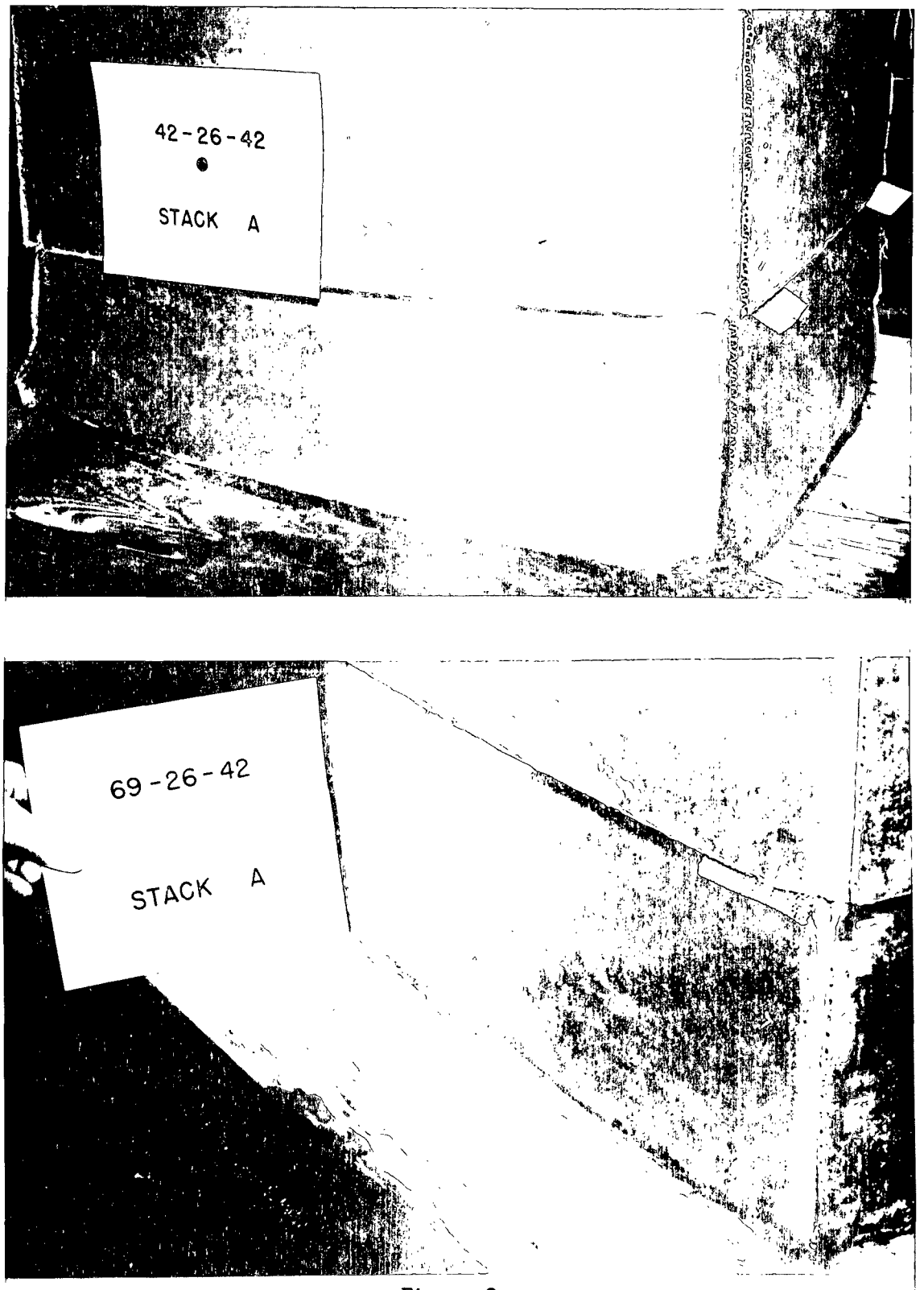


Figure 9

Appearance of Lower Boxes in Two Stacks after Seven Days

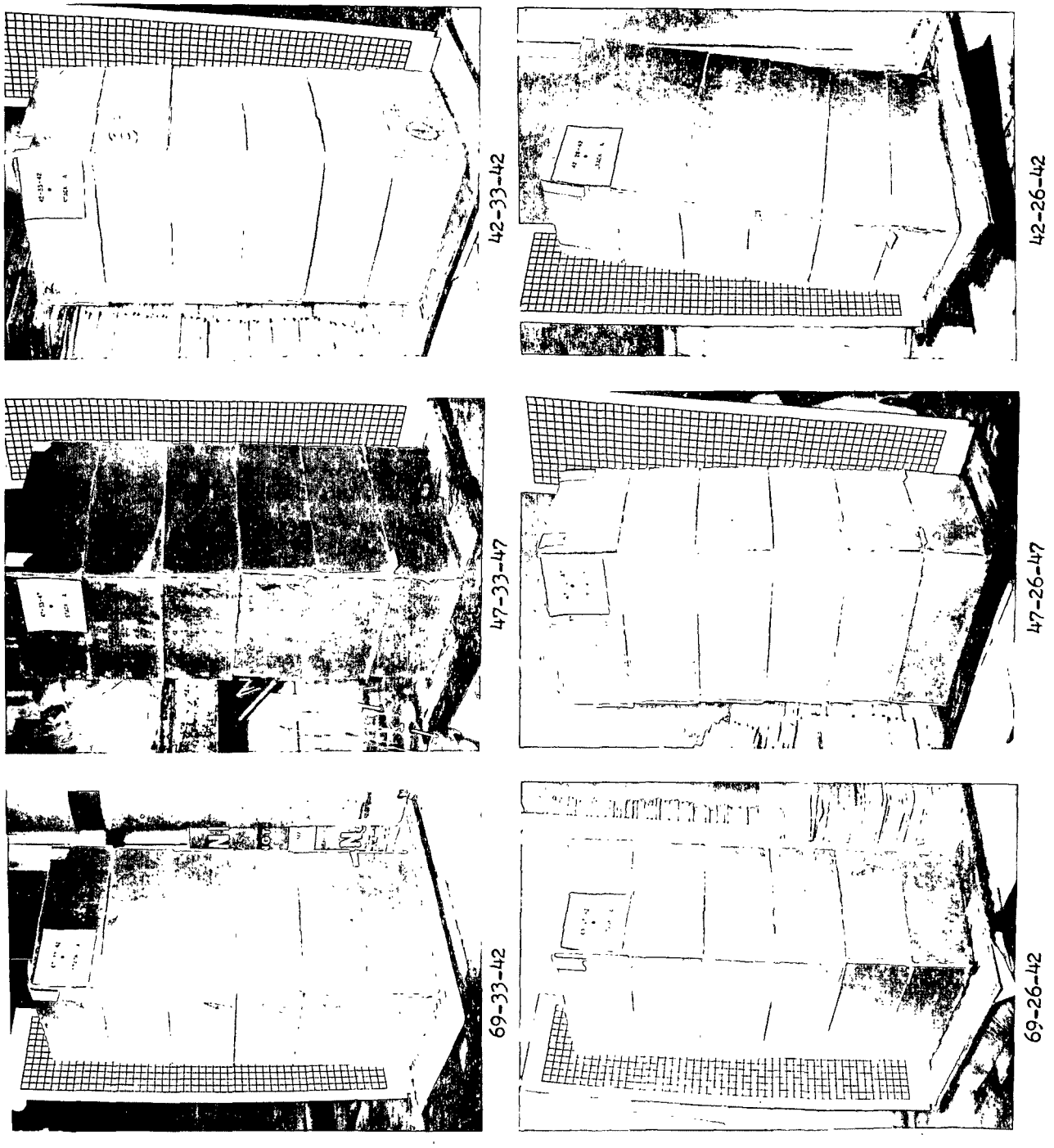


Figure 10a
Appearance of Stacks after Eleven Days (A Stacks)

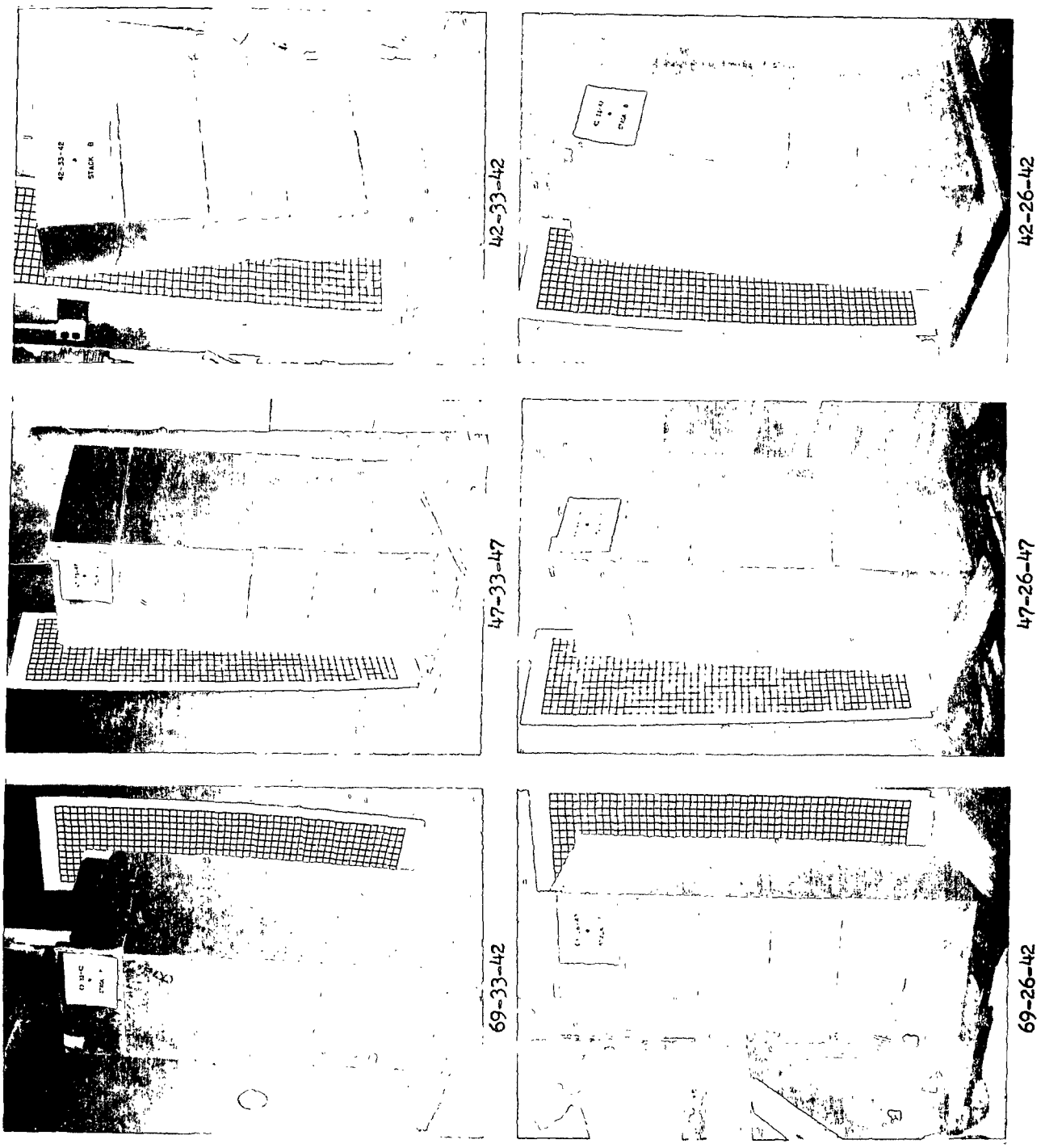


Figure 10b
Appearance of Stacks after Eleven Days (B Stacks)

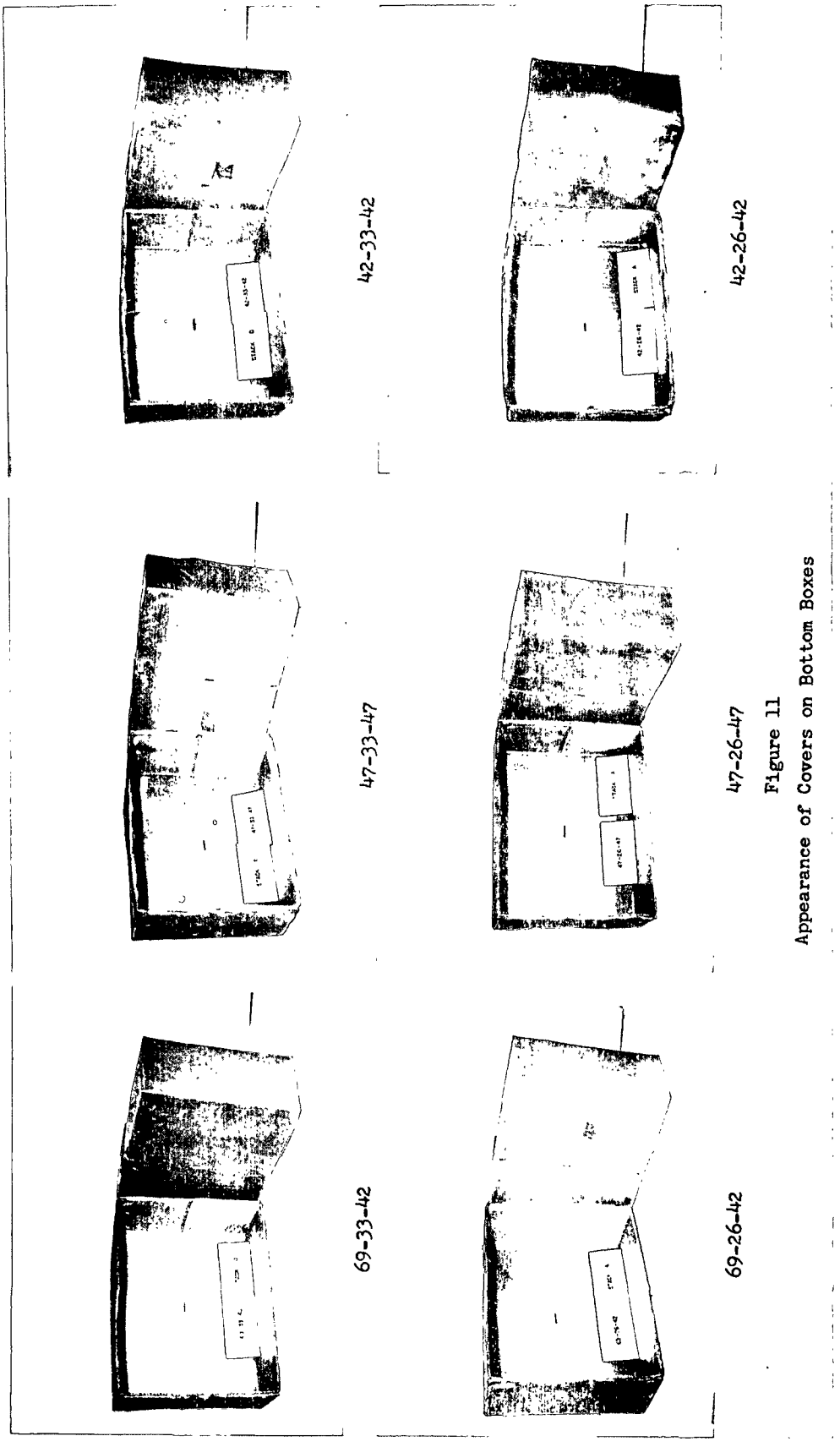


Figure 11
Appearance of Covers on Bottom Boxes

preceding the packing day and, therefore, may not have reached the cold room temperature prior to packing.

3. The cold room temperature of 40°F. was slightly higher than the temperature used in the previous study.

A summary of the observations made when the stacks were disassembled may be found in Table IX. Referring to the table, it may be noted that all boxes showed evidence of dishing on top and bottom and also wicking. No puddles were observed on the tops of any of the boxes. Delamination in areas of the bottom box were observed in three of the sets--i.e., 47-33-47, 42-33-42, and 42-26-42.

At the present time there is no gage against which a fiberboard box may be compared to determine whether it meets or falls short of the requirements for the wet-packing of poultry; however, the Ice-o-box is probably as good a reference as there is today. It is our understanding that the Ice-o-box performs satisfactorily but is not competitive price-wise, being approximately 20 to 25% higher than the present wirebound box. The information which is lacking is whether the Ice-o-box just barely meets the performance requirements or whether it exceeds them by a significant margin. In order that the results discussed above may be placed in proper perspective, cost estimates based on market price of the untreated boxes, the cost of the wax and an estimate of the cost of waxing have been prepared. These are listed below for each combination on a per-box basis together with the price of the wirebound and Ice-o-box as we understand the latter.

TABLE IX

REMARKS ON APPEARANCE OF BOXES AFTER UNSTACKING

	69-33-42	69-26-42	47-33-47	47-26-47	42-33-42*	42-26-42
Dishing "in" of top and "out" of bottom	1 to 1-1/4 inches	1 to 1-1/4 inches	1 to 1-1/2 inches	1 to 1-1/4 inches	1 to 1-1/4 inches	1 to 1-1/2 inches
Puddles on cover	none	none	none	none	none	none
Delamination,						
Bottom box	none	none	yes	none	yes	yes
Other boxes	none	none	none	none	none	none
"Wicking"--bottom box	about 1 inch	1/2 to 1 inch	1 to 1-1/2 inches	1 to 2 inches	1 to 1-1/2 inches	1 to 2 inches
Feel of top and bottom	soft	soft	soft	soft	soft	soft

* Box No. 2 of Stack B exhibited a 5-inch tear along the horizontal end score on the bottom when the stacks were disassembled.

Combination	Cost/Box, cents
69-33-42	42.8
69-26-42	40.5
47-33-47	38.6
47-26-47	35.3
42-33-42	36.6
42-26-42	34.2
Ice-o-box	55.0
Wirebound	45.0

The estimate of the market price of the untreated boxes was taken as the price quoted by a corrugated plant for untreated boxes of the specified size and grade. To this was added the cost of the wax used, based on a wax cost of 10¢ per lb.

Reviewing the above, it may be noted that all wax-treated combinations used in this study could be expected to cost less than the wirebound boxes in present use in the trade.

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R. C. McKee, Chief, Container Section

W. J. Whitsitt, Research Aide, Container Section